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The Wheat Blossom Midge *Contarinia tritici* (Kirby) was responsible for serious reduction in yields of wheat in the south and south-eastern districts of Ireland in 1951. The damage caused was so serious that in some areas the yield of grain from crops was no greater than the amount sown as seed. This unprecendented amount of damage was, without doubt, due to a combination of factors particularly favourable to the insect. Barnes in his studies of fluctuations in insect populations, has found rhythmic fluctuations in numbers of wheat blossom midges which, when both species were considered together, gave peaks of abundance at intervals of about 5 years. Although no similar studies have been carried out in Ireland, it is reasonable to assume that 1951 was a peak year of abundance for *C. tritici*. Moreover, there seems to have been perfect coincidence of midge and ear emergence, and during the time of oviposition very favourable weather prevailed.

In 1952 the weather during the spring was fine, as a result of which the period of wheat sowing was extended. This, in turn, prolonged the period of ear emergence, so that a high degree of coincidence of midge and ear emergence could not occur; in fact only some of the crops were at the correct stage for oviposition at the peak of midge emergence. Also in some districts the weather conditions were unfavourable for oviposition by the midges present at the time of ear emergence. The result, therefore, was that a large scale midge attack did not develop, and, with the exception of a few areas, yields of wheat were not noticeably reduced.

In 1953 the number of midges emerging was very much reduced, and no cases of serious damage were reported from any district.

In districts where there was a large emergence of midges in 1952, and where oviposition was taking place freely in favourable weather, the damage to crops was less than expected. An examination of weather reports for the latter half of June, 1952, showed that atmospheric humidity was low, with little or no dew at night and very little rain. This suggested that perhaps dry conditions retarded or prevented

the hatching of midge eggs which had been laid. It was surmised that, if hatching had in fact been retarded, the larvae might appear too late to prevent the formation of grain. Consequently, it was decided to carry out in 1953 a preliminary investigation on factors which might possibly have an influence on the hatching of the eggs. The factors selected for experiment were temperature and humidity.

In order to submit wheat ears containing eggs to various conditions of temperature and humidity chambers were devised in which these conditions could be controlled. The chambers were constructed of $\frac{1}{8}$ inch clear perspex and had the dimensions and form shown in figures 1 and 2. The bending of the perspex sheets was done so that a gap of approximately 1 inch was left between the free edges marked A and B in fig. 1. An oak batten 3 inches wide and $\frac{3}{4}$ inch thick was then fixed by wood screws over the edges A and B to complete the periphery of the chamber (still open at top and bottom). Holes were bored in the wood batten for the insertion of thermostat, thermometer, and hygrometer, and a piece of blockboard 15 inches square and $\frac{3}{4}$ inch thick was used as base for the chamber. Sixteen $\frac{3}{4}$ inch diameter holes were bored through the base in a circle of about 9 inches diameter for the admission of wheat ears. Each stem was held by a split cork and secured in position with plasticine. The top of the chamber was covered by a sheet of glass or clear perspex. The latter was used in the low temperature chambers, it being easier to cut a circular hole in it for the insertion of an ice container. A seal of putty was placed between the perspex frame and the baseboard and also between the frame and top to prevent passage of air through the chamber. Groups of assembled chambers were mounted in line on wooden trestles in such a manner that a bucket of water could be placed under each chamber to accommodate the roots of the wheat plants within it.

Temperature Control.

In each heated chamber a temperature above that of the laboratory was obtained by using a thermostatically controlled heater. The heater used was a 40 watt electric light bulb in a bulb holder secured to the centre of the base-board. The bulb was covered by a black metal box to exclude light and to assist in distributing the heat through the chamber. The thermostat was used directly on the power supply without a relay. It was found that, by using the thermostat in this way, it could easily be adjusted to give a differential of $\pm$ 2.5° F. which was considered good enough for the present experiment. A temperature below that prevailing in the laboratory was obtained by inserting a circular tin-can (about 4 inches diameter and 5 inches deep) through an opening of corresponding diameter cut in the perspex top of the chamber. The top rim of the tin-can was secured in putty to seal the opening. Ice was placed in the tin-can and renewed four times in every 24 hours. This kept the temperature of the tin-can at or near freezing point and had the effect of lowering the air temperature in the chamber 6° to 8° F. below that of the laboratory.

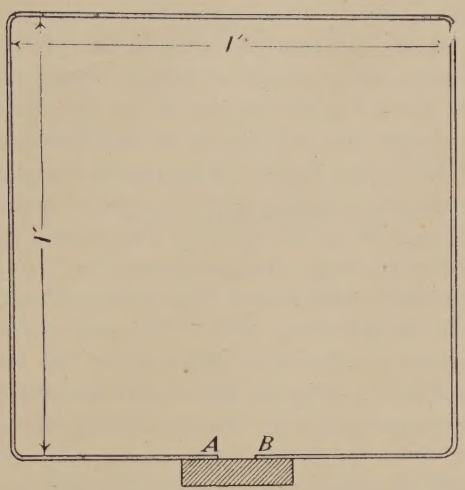

Fig. 1.—Plan of framework of chamber.

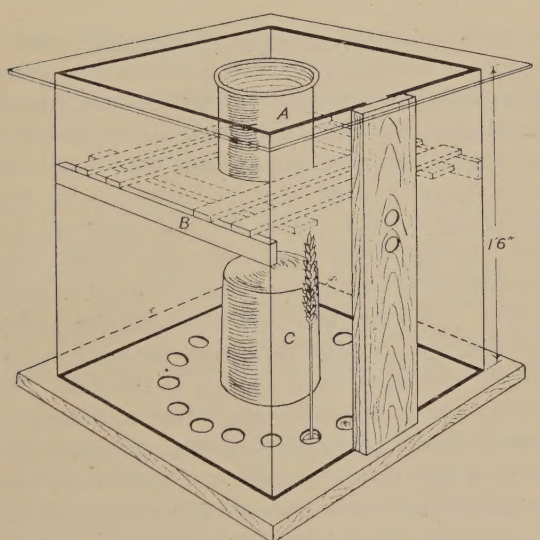

Fig. 2.—Sketch of chamber. A. Ice container; B. perspex strip cemented to side of container as support for shelf. C. heater (ice container and heater not used in same chamber).

Humidity Control.

It was difficult to secure humidity control within a chamber by the use of simple equipment on account of the moisture given off by the plants. When the wheat plants in the chamber had a large amount of foliage drying agents failed to control humidity, as the plants reacted to the drying of the atmosphere by continuing to transpire actively, thus keeping the humidity in the chamber high. When the wheat plants were stripped of their upper leaves, so that there was a minimum of leaf area in the chamber, sulphuric acid solutions kept the relative humidity fairly constant; e.g. analytical sulphuric acid of specific gravity 1.84 diluted with an equal volume of water maintained relative humidity of approximately 50% during the whole period of the experiment. The acid solution was exposed in circular glass dishes carried on a shelf placed just above the wheat ears. The shelf was made of $\frac{1}{4}$ inch thick perspex strips supported on similar strips cemented to the walls of the chamber. High humidity was obtained by spraying water into the chamber. The plants remained alive and were not attacked by moulds during the hatching experiment. Moulds developed later when the larvae were nearly fully grown. The relative humidity of the air in the chambers was measured by hair hygrometers previously calibrated against a dew-point apparatus.

Selection of Plants for Experiment.

An attempt was made to obtain eggs immediately after their being laid in the field by enclosing the tops of a number of wheat plants in waterproof paper bags just before the ears were expected to emerge. As soon as ear emergence commenced the paper bags were removed, the idea being that ears at the best stage of development for ovipositing midges would be exposed for one night. The following day these plants were pulled up and brought into the laboratory for examination. After examining many such plants it was apparent that the midge (*C. tritici*) had refained from laying in them— no eggs being found after one night's exposure. No explanation can be advanced as to why midges were reluctant to oviposit in the plants which had been covered. The foregoing method of obtaining plants for the experiment had to be abandoned, and, instead, ears newly emerged and which were judged to have been exposed for one night were selected in the field. This latter method was successful, most of the ears selected being found to contain some eggs. The whole plants were uprooted; the upper portions were placed in the chambers in the manner already described (one plant through each hole in the baseboard), and the roots of all the plants in a chamber were immersed in a bucket of water placed underneath. Samples of ears were taken from the chambers every day during the experiment and examined in order to ascertain how hatching was proceeding. The wheat used in the experiment was the variety "Progress", which in previous years proved very suspectable to injury by *C. tritici*.

Effect of Temperature on Hatching.

The temperatures used in the experiment were:—

(a) 80°—85° F.

(b) 70°—75° F.

(c) Laboratory temperature.

(d) 5°—7° F. below laboratory temperature.

Laboratory temperature was rather high during the experiment, the maximum day temperature ranging from 73° F. to 84° F. and the minimum night temperature from 52° F. to 64° F. The length of time required (in days) for wheat midge eggs to hatch under varying conditions of temperature and humidity is shown in the table. It will be seen that the time required for hatching decreased with increasing temperature within the range of the experiment. The rate of the development of the wheat blossoms, as judged by the time of extrusion of the anthers, was also influenced by temperature (a speedier development with increased temperature), and there seems to be a direct relationship between temperature and both the time required for hatching of the eggs and the time required for anther emergence.

Effect of Humidity on Hatching.

As it was not found possible to investigate the effect of a range of humidities, it was decided to confine observations to a *low humidity*, approximately 50% relative humidity, a *high humidity*, and the *varying humidity of air in the laboratory*.

Generally the effect of low humidity was to lengthen the time required for hatching as compared with high humidity. This applied also to ears exposed in the laboratory and kept dry, as compared with ears exposed in the laboratory and sprayed frequently with water. This delaying effect of low humidity on hatching was not observed to occur in the low temperature chambers, but, in fact, the behaviour of eggs at high and low temperatures needs further investigation.

The ultimate fate of eggs under conditions of low humidity would appear to depend upon the position in which they are laid. Eggs were found in two positions: on the membranous folded margins of the pales, and under the folds at the tips of the pales. In a random sample of ears taken from the field about 60% of the egg groups occurred under the folded margins at the tips of the pales. Eggs laid on the margins of the pales were exposed to atmospheric conditions when the blossoms opened to allow the anthers to emerge, with the result that such eggs became desiccated in a dry atmosphere and failed to hatch. Groups of desiccated eggs removed

from plants in the chambers and placed in water did not hatch, while fresh eggs placed in water hatched in 5 days. Eggs laid under the margins at the tips of the pales were protected from desiccation, and these hatched normally irrespective of humidity conditions. The slight retarding effect of a dry atmosphere on hatching is of considerable importance, as in many cases this means that hatching does not take place before the blossoms open, so that eggs laid on the margins of the pales could be killed by desiccation during a period of dry weather.

It is possible that, under natural conditions in the field, where plants are exposed to wind and sun, the desiccation of eggs may be more rapid than when they are kept in still air and protected from the sun as they were in the experiment. Groups of desiccated eggs were found on plants taken from the field, but these were only a small proportion of the total eggs laid. This only shows that under natural conditions eggs can fail to hatch, but, pending further observations, no general conclusions can be drawn as to the importance of this fact, or of its effect on the severity of wheat midge attack in any season.

Table showing effect of Temperature and Humidity on Time required for Hatching of Eggs of C. tritici.

Plants.	Temperature °F.	Relative Humidity	Hatch Commenced Days
In Chamber	80–85	100	2
Do.	80–85	45–50	*
Do.	70–75	100	3
Do.	70–75	45–50	4
Do.	Lab. Temperature	100	4
Do.	do. ...	60	5
Exposed in Laboratory	do. ...	Lab. Humidity ...	5
Do. ...	do. ...	Sprayed frequently with water.	4
In Chamber	5–7 below Lab. Temperature.	100	5
Do.	5–7 below Lab. Temperature.	50	5

* Continued observation of plants from these chambers was rendered impossible by an accident, but no hatched eggs were found after 3 days, and some of the groups of eggs seemed desiccated.

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